(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 November 2001 (08.11.2001)

PCT

(10) International Publication Number
WO 01/84355 A2

(51) International Patent Classification[7]: G06F 17/00

(21) International Application Number: PCT/US01/40545

(22) International Filing Date: 18 April 2001 (18.04.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/562,398 1 May 2000 (01.05.2000) US

(71) Applicant: TRADEWORX, INC. [US/US]; 304 Park Avenue South, New York, 10010 (US).

(72) Inventors: NARANG, Manoj; 260 West 52nd Street, New York, NY 10019 (US). STAMPFLI, Josh; 72 Hillcrest, Manhasset, NY 11030 (US).

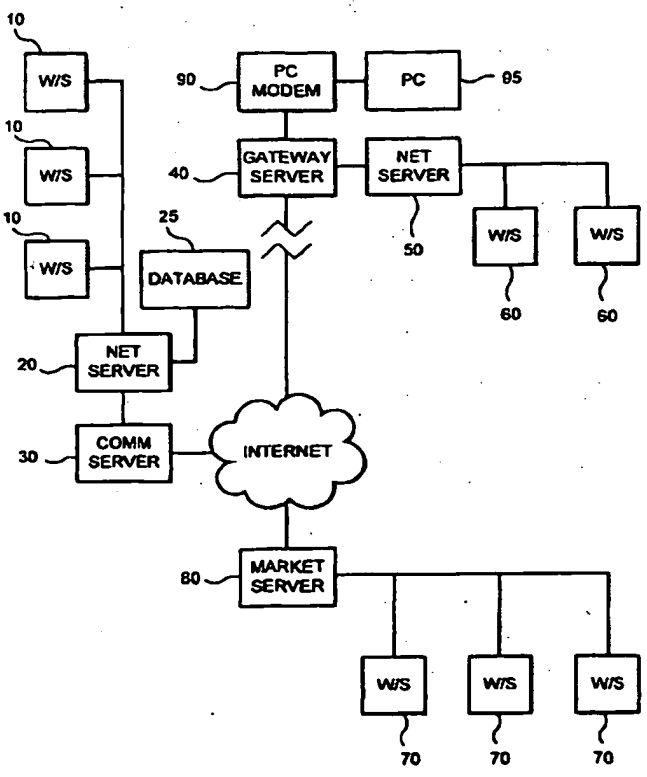
(74) Agent: BOLLINGER, James, M.; Hopgood, Calimafde, Judlowe & Mondolino, 60 East 42nd Street, New York, NY 10165 (US).

(81) Designated States *(national)*: AE, AG, AL, AU, BA, BB, BG, BR, BZ, CA, CN, CR, CU, CZ, DM, DZ, EE, GD, GE, HR, HU, ID, IL, IN, IS, JP, KP, KR, LC, LK, LR, LT, LV, MA, MD, MG, MK, MN, MX, NO, NZ, PL, PT, RO, SG, SI, SK, TR, TT, UA, UZ, VN, YU, ZA.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: DATA PROCESSING SYSTEMS, METHODS AND ARTICLES OF MANUFACTURE FOR DETERMINING AND MANAGING PORTFOLIO FINANCIAL DIVERSITY DATA



(57) Abstract: A data processing system for assessing select financial data and calculating a diversity index based thereon. The diversity index is a measure of the relative diversification of the portfolio and thus becomes an important measure of the risk exposure of the investor. The system further provides a collection of processing tools to facilitate risk management of investment portfolios.

WO 01/84355 A2

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DATA PROCESSING SYSTEMS, METHODS AND ARTICLES OF MANUFACTURE FOR DETERMINING AND MANAGING PORTFOLIO FINANCIAL DIVERSITY DATA

FIELD OF THE INVENTION

The present invention relates in general terms to a data processing system for measuring select properties of investment portfolios, assessing their relative diversification and providing management and advisory services in response thereto. More specifically, the present invention relates to a data processing system and technique implemented for the analysis, assessment, and management of investments by the determination of portfolio diversification, and a diversity index attendant to a given portfolio of investments.

BACKGROUND OF THE INVENTION

Simply stated, ordinary investors often fail to understand the need for portfolio diversification and, more importantly, techniques to insure that a particular portfolio is not concentrated in one or a few investment sectors. This problem has been long known to the investment communities and prior efforts have been proposed to address this issue. See for example, United States Patent No. 5,812,987 ("the '987 patent") issued to Donald L. Luskin and Lawerence G. Tint on September 22, 1998. There are numerous additional articles and treatise on the subject of investment diversification of which the common theme is the desire to avoid excessive concentrations in investment vehicles that react to market conditions in parallel fashion.

While the need for portfolio diversification has long been recognized, at least by professional money managers and stock brokers, placing this into practice has been surprisingly difficult. The critical issue is one of recognition. Most investors buy a number of individual shares and mutual funds expecting the mere fact of plural investments to reflect a substantial level of diversification. Indeed, it is easy to identify the need for diversification if the principal investments are concentrated in a single stock, such as Microsoft. And while a mutual fund includes dozens if not hundreds of

individual stocks, most mutual funds are organized with a specific investment objective. This may include a fund focusing on technology companies, such as Microsoft, or health care concerns like Merck.

Of course, concentrated investments do quite well when the market is favorable for such companies. As the personal computer industry has expanded, investors in Microsoft have been handsomely rewarded for their stock picks. Similarly, the holder of mutual fund shares directed to the same technology sector would likewise be favorably treated as the sector has grown. The difficulty arises when the technology sector suffers slowing growth or surprisingly poor earning reports. Not surprising, investors often react to these conditions by dumping shares, depressing the share price of both the individual stocks and the corresponding sector mutual funds. What is surprising to investors, however, is the coordinated drop in share prices of seemingly distinct issues, such as health care, with the technology sector. This occurs because there is an interrelationship between select stocks of companies that would otherwise appear to compete in different markets. Accordingly, the individual investor holding several different investment vehicles will often believe that this portfolio is diversified. In fact, it is not, and the portfolio is much more sensitive to sector market swings than the investor expects or desires.

The need for investors to maintain diverse portfolios has only increased with recent market dynamics. The increasing volatility of world financial markets has caused many financial portfolios to suffer significant erosion of their value, as losses in individual industries drive these non-diverse portfolios down. For example in the late 90s, the Asian contagion caused a dramatic decline in select sectors of the market, including semi-conductors and banking – industries that appear to be quite distinct. The holders of these stocks were hit particularly hard. In contrast, a financial portfolio that contains a truly diverse selection of investments allows an investor to minimize the risk of large percentage losses in the value of the financial portfolio. Instead, this diverse selection of investments will isolate the financial portfolio drops in individual sectors of the economy.

Moreover, as the amount of money flowing into financial portfolios rises and with the rising number of persons who are now investing, the need for a standard measurement of the diversity of these financial portfolios has dramatically increased. For example, many persons have become involved in investing in financial markets via Internet or discount brokerages. These investors often do not have the experience or the research capabilities of the large investment houses. As a result of this many of these portfolios are dangerously weighted in a small number of industries. A drop in the value of the companies within this sector of the economy could cause a disproportionate drop in the value of these investments.

Brokers at all levels have counseled investors on the need to purchase investments instruments in various sectors of the economy. These brokers have not, however, had an easily understood diversity measurement to indicate to individual investors their vulnerability to poor performances in individual sectors of the economy. There is thus a need for a standardized measurement of the diversity of the investment portfolios.

In addition, the large increase of individual investors acting on their own behalf though or with the assistance of discount brokerage services, has created a critical demand for analytical tools and investment support systems to provide the requisite portfolio analysis and advice to these individual investors. These relatively smaller capitalized investors – individuals, small institutions and even established brokerage concerns – all require easily navigated financial data management capabilities to facilitate effective risk controlled investment.

It was with the foregoing understanding that the present invention was made.

OBJECTS AND SUMMARY OF THE PRESENT INVENTION

It is the object of the present invention to provide a data processing system for receiving detailed information regarding a plurality of equity investments and processing this data to determine the diversification of investments.

It is another object of the invention to provide an interconnected communication platform to permit access to financial data management tools for performing analysis of financial data relating to investment portfolios and generating responsive data characterizations reflective of portfolio properties including investment diversification.

Further, it is an object of this invention to provide a method for analyzing the effect individual investments will have on the diversity of a financial portfolio.

It is yet another object of this invention to provide a method for analyzing and identifying investments that will optimize the diversity of a financial portfolio.

It is still another object of this invention to provide a method for analyzing the optimal allocation of capital among investments to maximize the diversity of a financial portfolio.

It is another object of the invention to provide a method for calculating the most risk adverse combination of a given set of investments.

Further, it is an object of this invention to provide a method to establish a benchmark financial parameter by which one can comparatively judge the diversity of certain commercially available investment vehicles.

It is yet another object of this invention to provide a method for analyzing the effect on diversity of combining different investments and commercially available investment vehicles.

The above and other objects of the present invention are realized in an illustrative data processing computer system comprising a processor, storage and memory, either configured as stand alone, or part of a private or large public integrated network. On a single processor system, a software program implemented in the memory and executed on the processor of the computer system maintains and manages the database of records corresponding to, *inter alia*, individual portfolios, and implements the requisite diversity calculations. For the network configuration, the present invention employs a platform comprising multiple servers interconnected, via communication transmission lines or wireless data transmission to allow data links therebetween. The servers are further connected to multiple, separate client computers forming a communication platform for establishing a multi-USER processing environment.

The illustrative embodiment of the present invention includes a program containing formal, rigorous mathematical models and configured to provide analysis of the composition of a financial portfolio or investment combinations. The clients, via the connected client computers, access these models for assessment of proposed investment combinations to determine the level of diversity associated with a given combination. Access is preferably accomplished on a Web Page using html/xtml programming for data presentation and USER input. An interactive session reveals a portfolio of the desired diversity index to the USER, which is thereafter implemented either in the same processing environment, or separately on a trading processor.

In accordance with the varying features of the present invention, the foregoing diversity processing system is coupled with a plurality of investment management analytical tools and investment data processors and databases, accessible via an integrated web page portal. Investors access the portal by establishing accounts with the administrator, entering portfolio details and establishing risk tolerance and other investment objectives. Access to the tools is thereby provided to the investor and individual investment decisions crafted based on the results of the analysis performed by the system tools specific to the investor's portfolio details. These decisions are then implemented by the integrated trading system, or linked to e-trade or similar external brokerage service. Pursuant to investor selected preferences, the system further provides one or more event driven alarms or real time notifications to the investor when system generated parameters fall outside of investor selected limits.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing aspects are better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

Figure 1 is a functional block diagram depicting the salient elements of the operating environment for the present invention;

Figure 2 is a logic flow diagram directed to the operating characteristics of the present invention;

Figure 3 is a logic flow diagram directed to select features of the present invention; and

Figure 4 is a logic flow diagram directed to additional features of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

First briefly in overview, the present invention relates to a method and system for processing select financial data for assessing the level of diversification of a portfolio of investments. This diversity determination involves the use of a computer workstation or data processing system to implement a series of complex mathematical calculations in assessing the diversity of a financial portfolio. Selected inputs for the calculation are collected. These inputs can include a number of disparate sources, including USER input, real time market feed, and/or database retrieval. The system incrementally calculates a series of intermediate matrix values, and these are then applied to the final index calculation. Variations of the process are selectable from the USER interface and permit iterative assessment of investment impact on portfolio diversity.

In general terms, the present invention measures the number of independent bets in a financial portfolio. The minimum diversity of a financial portfolio is 1, indicating that the financial portfolio is really only making one bet. The maximum diversity of a financial portfolio is equal to the number of holdings in a financial portfolio. The diversity of a financial portfolio may be analyzed as a function of the composition of the financial portfolio, in terms of the what investments the financial portfolio contains, the number of each individual invention, the number of units or shares of the individual investments contained in the financial portfolio, the volatility of the individual investments, the correlation between the individual investments and other like factors concerning the financial portfolio or the individual investments. Illustrative portfolios and index values are provided below:

EXAMPLES

Portfolio 1

Stock	Shares	Price
Alcoa	100	70
Applix	200	15

Diversity Score = 2

Portfolio 2

Stock	Shares	Price
Alcoa	100	70
Applix	1	15

Diversity Score = 1

Portfolio 3

Ford	100	42
GM	80	78

Diversity Score = 1.4

The preferred embodiment of the present invention may be implemented on any platform, operating system, and USER interface such as: Microsoft Windows NT or Windows/98 Operating System (OS), the IBM OS/2 operating system, the MAC OS, UNIX operating system, Sun/Sun OS-SunView; DEC VAX/VMS, or like systems. Processing attributes are programmed in a coding regimen compatible with the operating system and hardware environment. The choice of code, operating system, and hardware depends on the volume and speed of use expected from the processor.

With the foregoing overview in mind, attention is first directed to Figure 1, depicting the operating environment for the present invention. In this arrangement, a system proprietor maintains a separate discrete network, including a Net Server 20, linked via the network to plural workstations, 10. The system illustrated here further includes a Comm Server 30 for maintaining connections to the Internet, and Market Server 80. The Market Server provides equity trading and brokerage services, including real time market data and trading capabilities, via the linked Trading Workstations 70.

Continuing with Figure 1, the system comprises access by Internet connection from various sources on the Internet, including the World Wide Web by the Gateway Server 40. The Web is accessed either by dedicated network connections – Net Server 50 and associated Network Workstations 60; and by PC modem link 90 on conventional telephone lines.

In operation, the system proprietor provides Internet access to stored Web pages on its Net Server 20. Depending on the volume of expected traffic, this server can be stand alone, or a bank of servers, with associated routers for directing incoming Web traffic. As requests are received, initial Web pages are served to the investor/USERs. Depending on the nature of service, these will include select password/firewall security arrangements to insure proper usage. As data is requested, created, and/or stored, data passes to and from database 25.

Turning now to Figure 2, the logic diagram of the present invention is provided. Logic conceptually starts at block 100 and the USER ID is ascertained. This may be by conventional data entry, or other unique identifier, such as a cookie or command string, block 110. Test 120 discerns if the USER is new; if so, logic branches to block 130 and

the collection process for creating a new USER account. This data is then stored in the database and placed in active memory 140.

If the system recognizes the USER, ("No" to Test 120), logic continues to block 150 and the USER data, as stored, is recalled and placed in active memory. A Web page with plural options is then served to the USER and the system awaits for USER selected and entered commands from the main Web page selections, block 160.

Continuing with Figure 2, a USER selected operation is checked for authorization at Test 170. It is expected that the various tools on the main Web page will be provided on a USER-fee basis with incremental authorization mandated. Proper authorization branches logic to block 180 and the system displays the diversity index data collection table. Selected entries of data are recovered and iteratively processed in accord with the selected service, block 190. For example, for a new portfolio, the USER identifies the stock/shares for each entry. Alternatively, an existing portfolio may be pulled from memory and processed with changes or modifications. Based thereon, the system calculates the necessary intermediates and final diversity score, block 200.

In its simpliest form, the present invention receives data relating to one or more investments and calculates a diversity index value. To accomplish this the present invention applies the following algorithm to the portfolio data on the investment mix:

$$P=\begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ p_n \end{bmatrix} \qquad C=\begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & c_{22} & & \\ \vdots & & \ddots & \\ c_{n1} & & & c_{nn} \end{bmatrix} \qquad A=\begin{bmatrix} \sqrt{c_{11}} \\ \sqrt{c_{22}} \\ \vdots \\ \sqrt{c_{nn}} \end{bmatrix} \tag{1}$$

$$D=\frac{\left\{P^T \times A\right\}^2}{P^T \times C \times P} \tag{2}$$

In a preferred embodiment, the method for analyzing the diversity of a financial portfolio is performed by the above mathematical model that determines the diversity score as a function of an n by 1 portfolio

$$P = \begin{bmatrix} 100 \\ 80 \end{bmatrix} \qquad C = \begin{bmatrix} 4.947497 & 2.555974 \\ 2.555974 & 7.063337 \end{bmatrix}$$

composition matrix defined as P, where n is the number indicia identified as composing the financial portfolio; an n by n matrix which is the covariance matrix of the indicia identified as composing the financial portfolio defined as C; an n by 1 matrix of the square root of the diagonal elements of C otherwise the standard deviation of each indicia identified as composing the financial portfolio defined as A. The solution to this mathematical algorithm is defined as the diversity score or index, DI, of the analyzed financial portfolio.

$$A = \begin{bmatrix} 2.224296968 \\ 2.657693925 \end{bmatrix}$$

For illustration, a diversity score of 1.4 was determined for portfolio number 3 above in accordance with the following matrix associations.

D = 1.40

The covariance matrix is based on a per se well-known covariance statistical determination. In its simpliest form, this is accomplished by assessing the price movements of selected issues for the past 60 days. C_{ij} is the element of the covariance matrix in the ith row and jth column. This is calculated by:

$$C_{ij} = E(X_i * X_j) - E(X_i) * E(X_j)$$

where X_i is the ith random variable, X_j is the jth random variable, and X (random variable) is the daily percent return for the stocks under

analysis, and E, the expected values of X_i, X_j, and $X_i * X_j$ based on 60 days of daily percent of return data.

$$E(Xi) = \sum {}^{(Xi)}/_{60}$$

The diversity score may be based on various factors such as the individual investments contained within the financial portfolio, the number of shares or units of each investment composing the financial portfolio, the price of each investment included in the financial portfolio, the total monetary value of each individual investment contained within the financial portfolio, and/or the interaction between the individual investments contained within the financial portfolio. Any or all of the foregoing parameters may be received as a component of the indicia. This diversity score is then compared to the diversity score of other financial benchmarks, such as the Dow Jones, the S & P 500, the NASDAQ composite index and like benchmarks.

Figure 3 is a flow chart directed to adding or removing issues from the portfolio and assessing the impact this has on the diversity score. Logic begins conceptually at start block 300 and entry of USER, block 310. At the initial display, the sensitivity analysis tool is selected, block 320 and Test 330 confirms that access is permitted. (If no, block 335 prepares a report).

Once initiated, the selected portfolio is loaded, block 340 providing a listing of each investment contained therein. At Test 350, the USER selects the addition of a new issue into the portfolio (or new amounts of existing issues); logic branches to block 360 for entering the specific issue selected for consideration. This can be from a listing of recommended stocks profiled for compatibility, or taken from a stored database of known entries. In either event, the system has stored covariance values, or the processing capabilities to calculate the covariance values "on the fly".

Continuing with Figure 3, at block 370, the new Diversity Index is calculated – DI – and a Report on this is generated at block 380.

A similar logic is provided for dropping securities from the mix in the portfolio (or reducing amounts of existing securities), depicted schematically with Test 390 and blocks 400-420. This sequence is used to determine the new DI of the portfolio when an investment is removed from the mix. Logic then continues to the next cycle, block 430.

Turning now to Figure 4, a further feature of the present invention is provided. Specifically, the management of portfolio risk exposure may be automatically implemented by tracking portfolio diversity and adjusting investments based on deviations from a minimum level of diversity sought by the investor.

This is accomplished in accordance with the following, with logic beginning at start block 500 and the entry of the USER ID at 510. Based on the entered ID, the system recalls the current portfolio (ID) for that USER at block 520.

At Test 530, the system checks to determine if an "event" has occurred that would necessitate a system review of the portfolio in question. This event is illustrated here as a period review, triggered by the passage of a select time interval, *e.g.*, three months. Other events, such as stock market index levels or changes, interest rate movements, and the like may be used and will be entered in a set up routine for selectable engagement.

Assuming a positive response to Test 530, logic branches to block 540 and the system calculation of the DI for that portfolio. Importantly, any changes in the portfolio content will now be incorporated into this calculation which is otherwise undertaken as discussed above in relation to Figure 2. Once determined, the current DI is compared to a stored minimum DI value, Test 550. If the current DI is less than the set minimum, logic advances to a portfolio alarm and adjustment routine, block 560. Portfolio adjustment can proceed in one of several ways. The system may propose corrective additions to or deletions from the portfolio which may be selected by the investor and thereafter automatically executed by the linked trading processor. Alternatively, a stored collection of acceptable investments may be recalled and used to modify the portfolio composition. Logic thereafter returns to the DI calculation at block 540 and

the diversity is recalculated for the adjusted portfolio – passing through the same logic sequence to insure compliance with the minimum DI criteria.

Although the invention has been described in detail for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. In combination in a data processing system for selectively assessing financial data relating to specified investment vehicles and determining a diversity score, comprising:

data input for collecting financial data on one or more investments forming a portfolio;

data processor for assessing the selected financial data and calculating a degree of diversity for said portfolio; and

data reporting for outputting said diversity in terms of a diversity score.

2. The system of claim 1 wherein said data processor includes microprocessor controlled implementation of program based matrix analysis of the following values of a selected portfolio:

P_x = price of share

C_{xy} = covariance value

3. The system of claim 1 wherein said data processor includes database memory storage for storage of data relating to said portfolio.

4. The system of claim 3 wherein said data processor further tracks plural portfolios.

5. The system of claim 4 wherein said system provides selectable adjustment to said portfolios and assessment of new diversity index values based thereon.

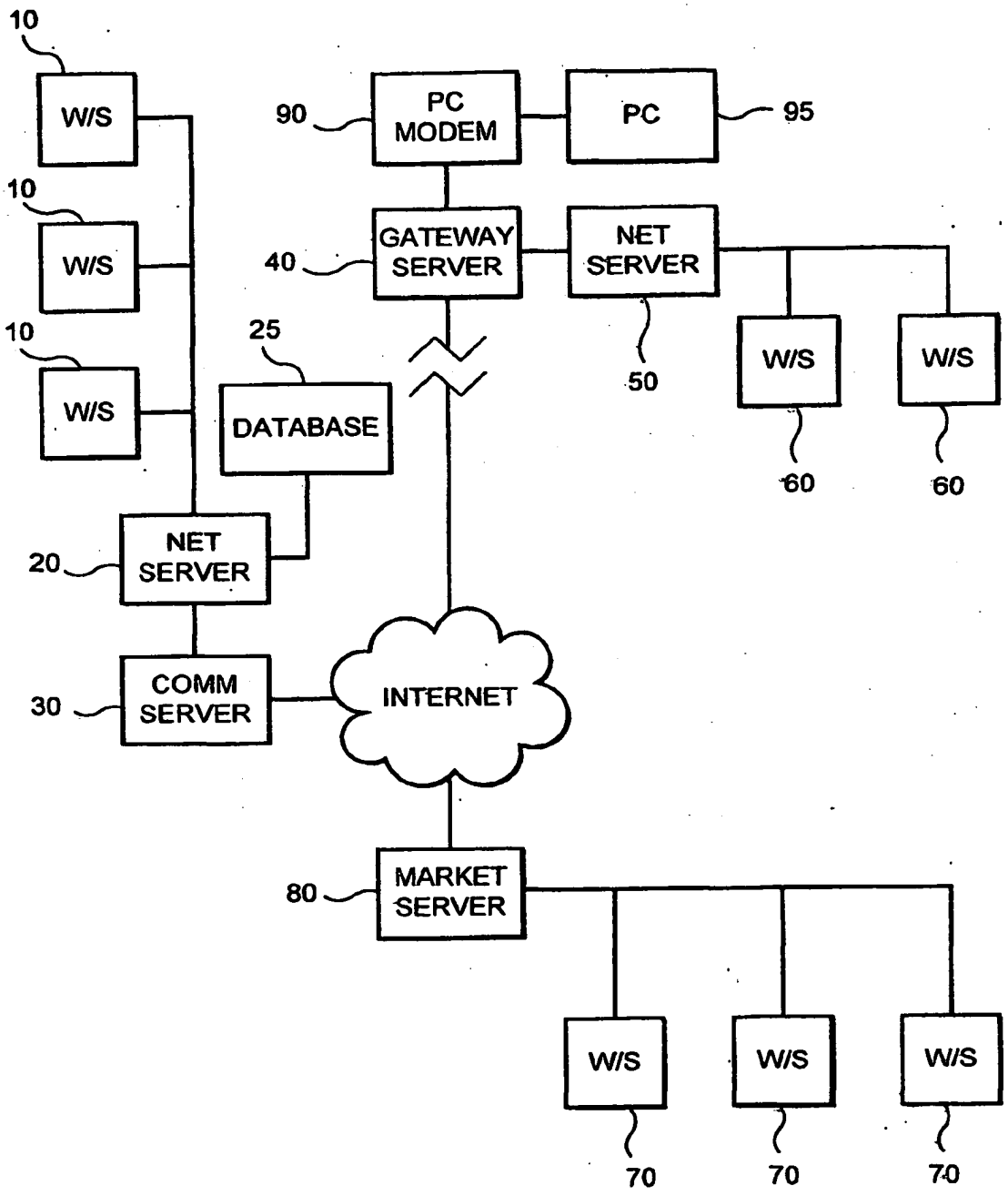

10
W/S
10
W/S
10
W/S
90
PC MODEM
PC
95
40
GATEWAY SERVER
NET SERVER
50
25
DATABASE
W/S
W/S
60
60
20
NET SERVER
30
COMM SERVER
INTERNET
80
MARKET SERVER
W/S
W/S
W/S
70
70
70

FIG. 1

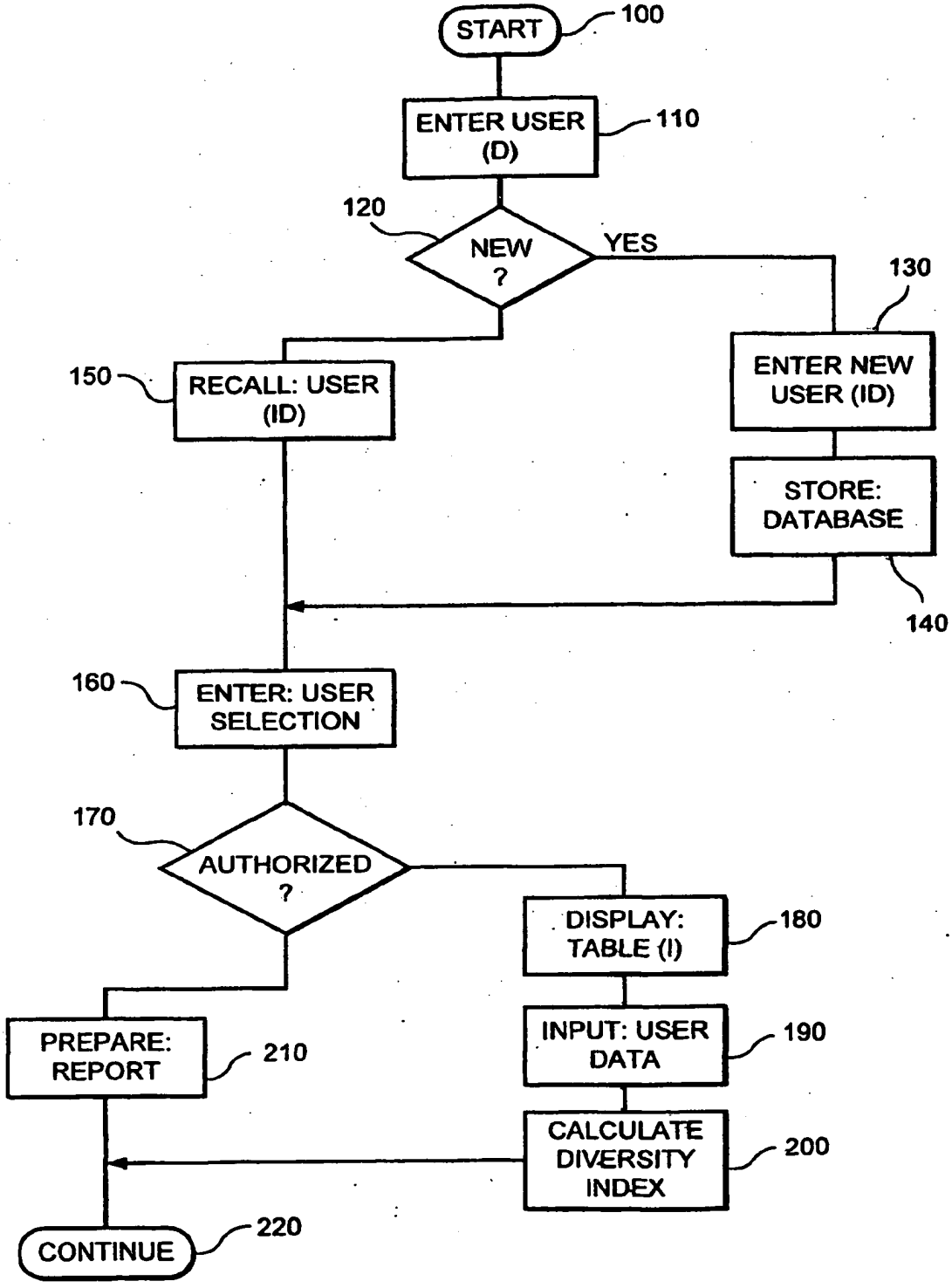

START
100
ENTER USER (D)
110
120
NEW ?
YES
130
ENTER NEW USER (ID)
STORE: DATABASE
140
150
RECALL: USER (ID)
160
ENTER: USER SELECTION
170
AUTHORIZED ?
DISPLAY: TABLE (I)
180
INPUT: USER DATA
190
CALCULATE DIVERSITY INDEX
200
PREPARE: REPORT
210
CONTINUE
220

FIG. 2

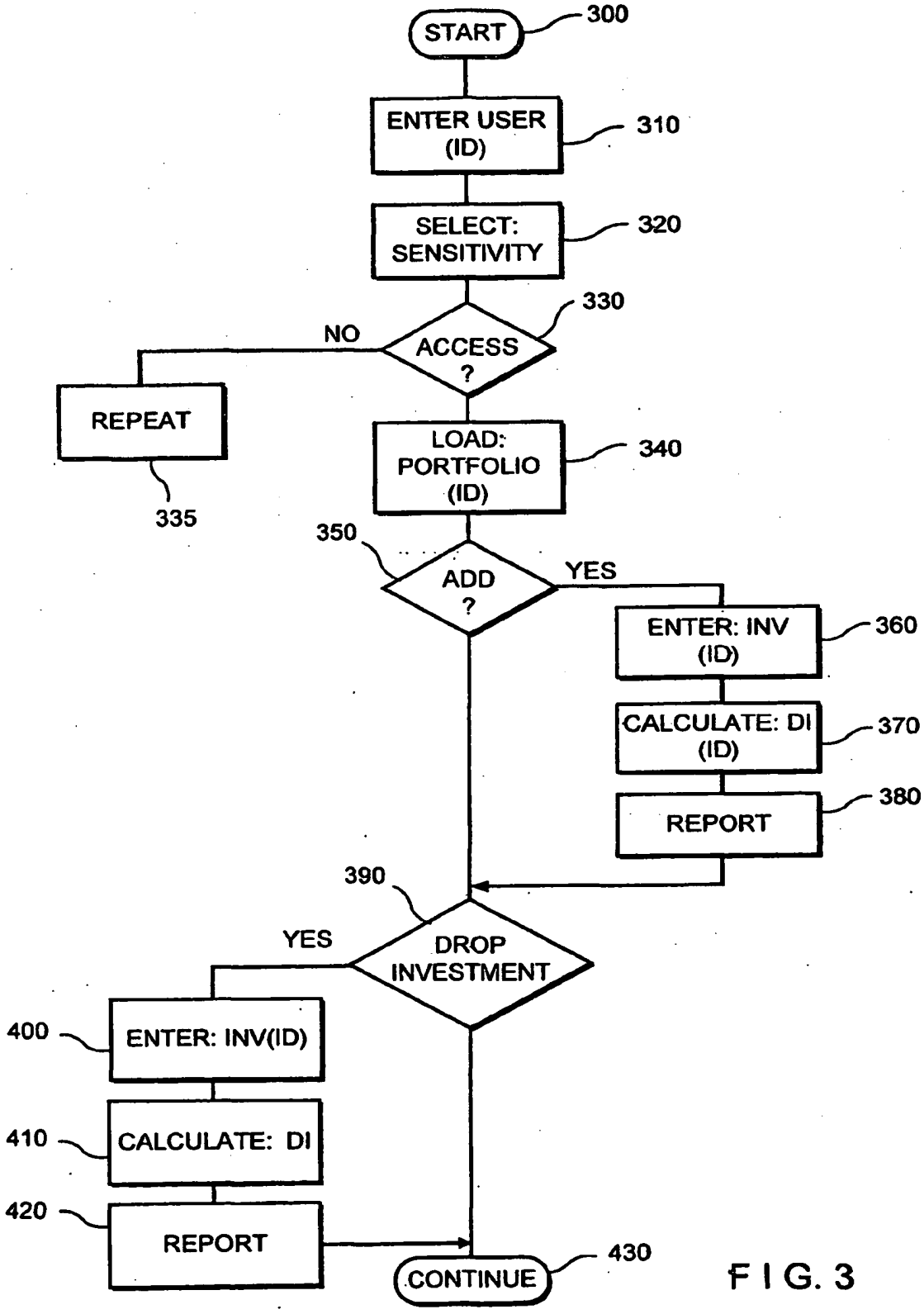

START
300
ENTER USER (ID)
310
SELECT: SENSITIVITY
320
ACCESS ?
330
NO
REPEAT
335
LOAD: PORTFOLIO (ID)
340
ADD ?
350
YES
ENTER: INV (ID)
360
CALCULATE: DI (ID)
370
REPORT
380
DROP INVESTMENT
390
YES
ENTER: INV(ID)
400
CALCULATE: DI
410
REPORT
420
CONTINUE
430

FIG. 3

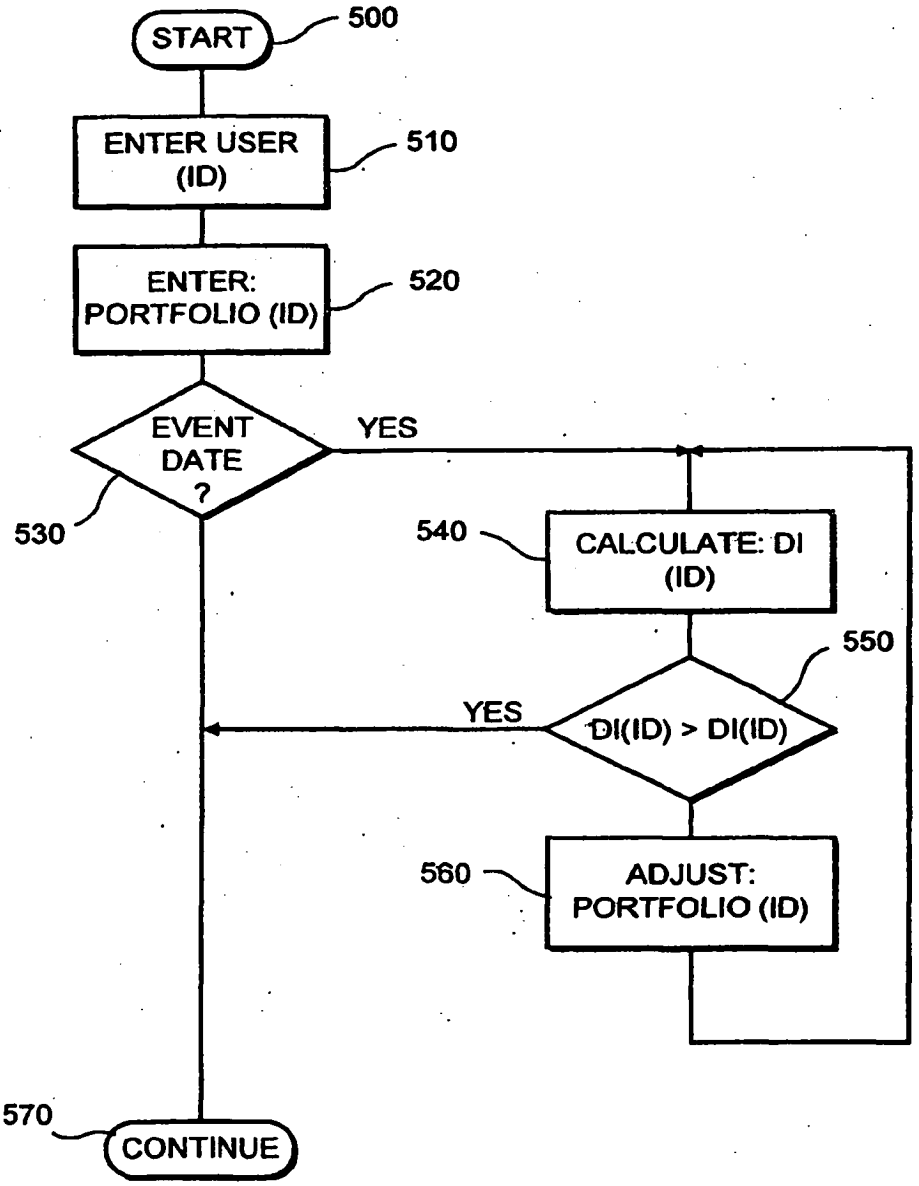

START
500
ENTER USER (ID)
510
ENTER: PORTFOLIO (ID)
520
EVENT DATE ?
530
YES
540
CALCULATE: DI (ID)
550
YES
DI(ID) > DI(ID)
560
ADJUST: PORTFOLIO (ID)
570
CONTINUE

FIG. 4